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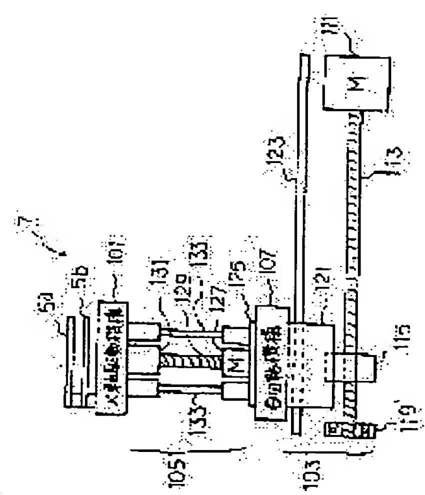
(71)Applicant : TOKYO ELECTRON LTD
TERU KYUSHU KK

(72)Inventor : USHIJIMA MITSURU
YOSHIOKA KAZUTOSHI
YAMAGUCHI TOMOZO

(54) PRODUCTION DEVICE FOR SEMICONDUCTOR

(57)Abstract:
PURPOSE: To obtain a semiconductor production device, in which no dust is generated from the movable section of a carrying mechanism, by interposing a lubricant having low dusting characteristics to the sliding section of the carrying mechanism.
CONSTITUTION: The sliding section of a carrying mechanism 7 such as the screwing section of a ball screw 113 and a ball nut 115 and the screwing section of a ball screw 129 and a ball nut 131 are coated with grease having low dusting characteristics. The abrasion of these sections is prevented at that time, and the oxidation, thermal decomposition, shearing, modification, evaporation, etc., of grease are difficult to be generated, thus hardly generating dust from grease itself. Accordingly, the generation of dust from the sliding section of the carrying mechanism 7 can be obviated.



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SPECIFICATION

1. Title of the invention

Semiconductor Manufacturing Equipment

2. What is claimed is:

Semiconductor manufacturing equipment in which a sample to be processed is carried by a conveying mechanism and the sample to be processed undergoes processing; wherein a lubricating agent with low-dusting characteristics is interposed in a plurality of sliding sections of said conveying mechanism.

3. Detailed Description of the Invention

[Object of the Invention]

(Utilization Field in Industry)

The present invention relates to semiconductor manufacturing equipment.

(Prior Art)

In semiconductor manufacturing equipment, semiconductor wafers undergo a variety of processes in a plurality of processing steps, and in recent years, as the semiconductors formed on the above-mentioned semiconductor

wafers are enhanced in integration density, the number and sophistication of above-mentioned processing steps are increasingly growing.

For example, in resist-processing steps for a semiconductor wafer, coating and developing steps relating to a resist are being more sophisticated by their diversification such as: coating the semiconductor wafer with a resist film, further coat-forming a developed film on a formed resist film, and forming multi-layer resist films for creating a flattened layer of resist.

Meanwhile, the manufacturing environment for semiconductors, coupled with the sophistication mentioned above, is also required to be even cleaner in order to minimize defects in semiconductor elements due to accumulation of dust particles. It is thus necessary to provide more-advanced clean rooms and to reduce dusting from the equipment itself more stringently.

As an example of the semiconductor manufacturing equipment allowing for these circumstances, a resist coater, for example, is already proposed, by which a sample to be processed, for example, a semiconductor wafer undergoes processing in a plurality of processing mechanisms after the wafer has been carried thereto by means of a common conveying mechanism.

By the way, movable sections of the conveying

mechanism in the above conventional equipment, such as the threadable engagement section between a ball screw and a ball nut, requires coating with a lubricating agent.

Accordingly, it is considered that movable portions such as the above-mentioned ball screw and ball nut require coating with a grease most commonly used for general industrial machines other than semiconductor manufacturing equipment.

(Problems to be Solved by the Invention)

In general, however, such general-purpose grease as mentioned above is not necessarily excellent in oxidation resistance, thermal stability, shear stability, chemical stability, low evaporability, or the like. There has been the problem, therefore, that the effects of the high-temperature environment, mechanical shocks, and various chemical reactions occurring during semiconductor-manufacturing process steps cause the grease to easily suffer oxidation, thermal decomposition, shearing, chemical modification, evaporation, or the like, thus resulting in dust stemming from the grease itself. Such dust is present in the same atmosphere as that of the semiconductor wafer, and therefore, the dust sticks to the wafer, thus deteriorating a production yield.

The present invention was made in order to solve the above problems, and its object is to provide semiconductor

manufacturing equipment that does not generate dust from movable sections of a conveying mechanism used in the equipment.

[Composition of the Invention]

(Means for Solving the Problems)

In order to achieve the above object, the present invention is characterized in that a lubricating agent with low-dusting characteristics is interposed in a plurality of sliding sections of the conveying mechanism mentioned above.

(Operation)

In the present invention, wear on sliding sections of the conveying mechanism is prevented by the fact that a lubricating agent with low-dusting characteristics is interposed in each of those sections. The low-dusting characteristics of this lubricating agent also reduce dusting from the lubricating agent itself.

(Embodiment)

An embodiment in which the semiconductor manufacturing equipment pertaining to the present invention is applied to a resist coater is described in detail below using the accompanying drawings.

As shown in Fig. 3, a conveying mechanism (wafer conveying robot) 7 is disposed near a center of a main unit 1. The conveying mechanism that has, for example, as a holding unit for holding a sample to be processed (for

example, a semiconductor wafer 3), two vertically arranged vacuum-chucking arms 5a and 5b both capable not only of holding the semiconductor wafer 3 by vacuum-chucking it, but also of being operated independently of each other. The conveying mechanism 7 is adapted so that these vacuum-chucking arms 5a and 5b can be moved independently of each other and in an X-direction (longitudinal), a Y-direction (lateral), a Z-direction (vertical), and a Θ-direction (rotational) each.

The above-mentioned conveying mechanism 7 is described in further detail below. As shown in Figs. 1 and 2, the conveying mechanism 7 comprises, in addition to the above-mentioned vacuum-chucking arms 5a and 5b, an X-axis driving unit 101, a Y-axis driving unit 103, a Z-axis driving unit 105, and a Θ-rotating unit 107.

The Y-axis driving unit 103 is constructed as follows: a ball screw 113 rotated by a Y-axis driving motor 111 having a rotation axis in a horizontal direction is threadably engaged with a ball nut 115, and has an end fixed to a main unit (not shown in the figures) of the equipment via a bearing 119; the above-mentioned ball nut 115 is connected to the Θ-rotating unit 107 via a connecting member 121, and this connecting member 121 slides along a surface of a guide rail 123 provided in parallel to the ball screw 113, on the main unit of the

equipment.

A sliding section of the Y-axis driving unit 103, for example, a threadable engagement section between the ball screw 113 and the ball nut 115, is coated with a grease which has low-dusting characteristics, such as the Krytox (trade name) manufactured by DuPont, the Temprex (trade name) manufactured by Esso Oil, the FOMBLIN (trade name) manufactured by Vacuum Grease, the Z15 (trade name) manufactured by Kyodo Oil), or the ZLHT (trade name) manufactured by Shell Oil). The grease of low-dusting characteristics here refers to a grease whose thermal stability, shear stability, chemical inertness, and low-dusting characteristics are all superior to those of other general-purpose greases used for general industrial machines. In other words, the aforementioned grease is such that despite the effects of exposure to a high-temperature environment, mechanical shocks, various chemical reactions, and the like, during various semiconductor-manufacturing process steps, the grease is not prone to oxidation, thermal decomposition, shearing, chemical modification, evaporation, or the like, and consequently that dusting from the grease itself does not occur.

The Θ-rotating unit 107 has a disc-like horizontal rotary table 125 with a Z-axis driving unit 105 provided

thereon.

The Z-axis driving unit 105 is constructed as follows: an end of a ball screw 129 rotated by a Z-axis driving motor 127 having a rotation axis in a vertical direction is threadably engaged with a ball nut 131; the ball nut 131 is connected to the X-rotating unit 101; between the above-mentioned rotary table 125 and the X-rotating unit 101, a plurality of Z-axis guide support columns 133 each extendible/retractable in a vertical direction are interposed, thus horizontally supporting the X-rotating unit 101; and a sliding section of the Z-axis driving unit 101, for example, a threadable engagement section between the above-mentioned ball screw 129 and ball nut 131 is coated with a low-dusting lubricating agent of a type similar to the foregoing.

The X-axis driving unit 101 holds vacuum-chucking arms 5a and 5b, and moves the vacuum-chucking arms 5a and 5b in an X-axial direction.

The operation of each driving unit and rotating unit described above is controlled by a controller not shown in the figures.

At one side of the above-mentioned conveying mechanism 7, a plurality of processing units are provided in juxtaposed form from the left of Fig. 1 to the right thereof and along the guide rail 123 provided in the Y-

direction of the conveying mechanism 7. The above-mentioned plurality of processing units are: an HMDS processing unit 11 for improving adhesion between, for example, a semiconductor wafer 3 and a resist film; a pre-baking unit 13 for heat-evaporating a solvent left in a resist applied to the semiconductor wafer 3; and a cooling unit 15 for cooling the semiconductor wafer 3 after it has been heated by the pre-baking unit 13. The pre-baking unit 13 is configured into a multi-stack arrangement with, for example, two to four stacks of units, as required.

Meanwhile, at the front position on a moving route 9 provided at the opposite side to each unit mentioned above, a plurality of processing units are also disposed: a coating unit 17 for rotationally coating, for example, a surface of a semiconductor wafer 3 with a resist; and a surface-covering layer-coating unit 19 which, for the purpose of, for example, preventing irregular reflection of light during exposure, forms a surface-covering layer, such as a CEL film, on a surface of the resist applied to the semiconductor wafer 3.

The above-mentioned conveying mechanism 7 can arbitrarily convey the semiconductor wafer 3 to each processing unit mentioned above, and a processor unit (wafer process station) 21 is constructed from the conveying mechanism 7 and each processing unit mentioned

above.

At a left position of the processor unit 21 is disposed a loading/unloading unit (cassette station) 33. The loading/unloading unit 33 comprises: a storage container for accommodating unprocessed semiconductor wafers 3, for example, a wafer carrier (cassette) 23 capable of accommodating, for example, 25 wafers; a wafer carrier 25 for accommodating processed semiconductor wafers 3; a loader 29 with a vacuum-chucking arm 27 for holding a semiconductor wafer 3 by vacuum-chucking it; and a plurality of liftable resting pins 31.

Next, the operation of this resist coater is described below.

In operation, first, an X-axis moving unit 35, a Y-axis moving unit 37, and a Θ-rotating unit 39, each belonging to the loading/unloading unit 33, are operated to move the vacuum-chucking arm 27 to below the wafer carrier 23. Next, the wafer carrier 23 is moved downward by a lifting unit (not shown). Thus, one unprocessed semiconductor wafer 3 prestored within the wafer carrier 23 is placed on the vacuum-chucking arm 27 and held by being vacuum-chucked thereby. The vacuum-chucking arm 27 is then moved in an X-direction and then the unprocessed semiconductor wafer 3 is thus taken from the wafer carrier 23. Thereafter, the arm 27 is moved in a Y-direction so

that the wafer 3 is rested on the resting pins 31.

Next, by moving the conveying mechanism 7 of the processor unit 21 to the left in a Y-direction of the figure, the unprocessed semiconductor wafer 3 rested on the resting pins 31 of the loading/unloading unit 33 is received and vacuum-chucked by the vacuum-chucking arm 5a.

This vacuum-chucking arm 5a is moved in a direction of, for example, the HMDS processing unit 11 according to a particular processing step. The above-mentioned semiconductor wafer 3 is then set in the HMDS processing unit 11 and then HMDS [$(CH_3)_3SiNHSi(CH_3)_3$] is applied in vapor form to the semiconductor wafer 3. At the same time, the loading/unloading unit 33 is operated and one semiconductor wafer 3 to be next processed is removed from the wafer carrier 23 and rested on the resting pins 31. Subsequently, the coater operates similarly to the above.

Meanwhile, after completion of the processing step at the HMDS processing unit 11, the conveying mechanism 7 is moved, then the semiconductor wafer 3 that has undergone HMDS processing is removed from the HMDS processing unit 11 by means of, for example, the vacuum-chucking arm 5b, and this semiconductor wafer 3 is set in a first coating unit 17 in order to undergo next processing. After this setting operation, the semiconductor wafer 3 rested on the resting pins 31 is received by the conveying mechanism 7 and set in

the HMDS processing unit 11. At this time, the unprocessed semiconductor wafer 3 rested on the resting pins 31 may be received beforehand by means of the vacuum-chucking arm 5a of the conveying mechanism 7 and then the operation described above may be performed using the vacuum-chucking arm 5b.

At the coating unit 17 mentioned above, the surface of the semiconductor wafer 3, during its rotation, is dripwise coated with a required amount of resist by means of, for example, spin-coating. The semiconductor wafer 3, after being coated by this coating unit 17, is set in the pre-baking unit 13 by the conveying mechanism 7 and heated by the pre-baking unit 13 prior to next processing.

As described above, a semiconductor wafer 3 is carried to and set in the HMDS processing unit 11, the coating unit 17, the pre-baking unit 13, the cooling unit 15, and the surface-covering layer-coating unit 19, in that order, so as to undergo respective process steps.

After completion of a processing step in the surface-covering layer-coating unit 19 as the final processing step in the resist coater of the above-described construction, the semiconductor wafer 3 is removed from the surface-covering layer-coating unit 19 by the conveying mechanism 7 and carried to the left of the Y-direction in the figure.

After being carried to a left end of the processor unit 21 in the figure by the conveying mechanism 7, the semiconductor wafer 3 is rested on the resting pins 31 of the loading/unloading unit 33.

Also, if an unprocessed semiconductor wafer 3 is already present on the resting pins 31, this unprocessed semiconductor wafer 3 is picked from the resting pins 31 beforehand by the vacuum-chucking arm 5a or 5b, whichever is not holding a processed semiconductor wafer 3.

Next, the above-mentioned semiconductor wafer 3 is held and carried by the vacuum-chucking arm 27 of the conveying mechanism 33 and a processed semiconductor wafer 3 is stored into the wafer carrier 25.

In this manner, semiconductor wafers 3 are sequentially loaded from the wafer carrier 23 of the loading/unloading unit 33, then sequentially carried to each processing unit within the processor unit 21 by the conveying mechanism 7 in order to undergo a resist-coating process, and after the process, unloaded into the wafer carrier 25 of the loading/unloading unit 33.

As described above, in the present embodiment, sliding sections of the conveying mechanism 7, for example, threadable engagement sections between the ball screw 113 and the ball nut 115 and between the ball screw 129 and ball nut 131, are coated with a low-dusting grease. Wear

on these sections is thus prevented. The grease is not prone to oxidation, thermal decomposition, shearing, chemical modification, evaporation, or the like, and almost no dusting from the grease itself occurs.

Incidentally, the Y-axis driving unit 103 was independently operated using, as the low-dusting grease mentioned above, the Krytox (trade name) manufactured by DuPont, and the number of dust particles which dropped onto a downward required region of the ball screw 113 during the above operation was measured. As a result, 76 dust particles with particle sizes of 0.17 microns or more, but less than 0.50 microns, were detected and no larger dust particles detected. By contrast, a general-purpose grease for general industrial machines was used alternatively to the low-dusting grease mentioned above and a similar measurement was conducted under the same conditions as the foregoing. Resultingly, 2,701 dust particles in all occurred: 648 with particle sizes of 0.17 microns or more, but less than 0.50 microns, 999 with particle sizes of 0.50 microns or more, but less than 2.00 microns, and 1,054 with particle sizes of 2.00 microns or more.

Hence, according to the present embodiment, it is possible to provide a resist coater in which almost no dust stems from sliding sections of the conveying mechanism 7.

The equipment of the present invention can also be

applied/used as a developer by substituting, for example, the coating unit in the above-mentioned embodiment by a developing unit when constructing the equipment.

(Effects of the Invention)

As described above, according to the present invention, it is possible to provide semiconductor manufacturing equipment that does not generate dust from movable sections of the conveying mechanism in the equipment, since a lubricating agent with low-dusting characteristics is interposed in a plurality of sliding sections of the conveying mechanism and thus prevents wear on the sliding sections and since the low-dusting characteristics of the above-mentioned lubricating agent do not generate dust from the lubricating agent itself.

4. Brief Description of the Drawings

Fig. 1 is a view showing major sections of a conveying mechanism used in a resist coater which embodies the present invention; Fig. 2 is an external view of the conveying mechanism shown in Fig. 1; and Fig. 3 is a view showing the construction of the resist coater embodying the present invention.

7 ... Conveying mechanism

21 ... Processor unit

113, 129 ... Ball screws

115, 131 ... Ball nuts